Express Mail No.: EV355036878US

APPLICATION FOR UNITED STATES LETTERS PATENT

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Title: **LAMELLAR MELTBLOWING DIE APPARATUS AND METHOD**

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SPECIFICATION

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LAMELLAR MELTBLOWING DIE APPARATUS AND METHOD

Field of the Invention

The present invention generally relates to apparatus and methods for extruding thermoplastic filaments and, more particularly, apparatus for melt blowing multi-component or single component filaments.

Background of the Invention

Melt spinning techniques, such as spunbonding or meltblowing techniques, for extruding fine diameter filaments find many different applications in various industries including, for example, in nonwoven material manufacturing. This technology generally involves extruding a thermoplastic material from multiple rows of discharge outlets extending along the lower surface of an elongate spinneret. Spunbonded and/or meltblown materials are used in such products as diapers, surgical gowns, carpet backings, filters and many other consumer and industrial products. The machines for meltspinning such materials can be very large and include numerous filament discharge outlets.

For certain applications, it is desirable to utilize two or more types of thermoplastic liquid materials to form individual cross-sectional portions of each filament. Often, these multi-component filaments comprise two

components and, therefore, are referred to as bicomponent filaments. For example, when manufacturing nonwoven materials for use in the garment industry, it may be desirable to produce bicomponent filaments having a sheath-core construction. The outer sheath may be formed from a softer material which is comfortable to the skin of an individual and the inner core may be formed from a stronger, but perhaps less comfortable material having greater tensile strength to provide durability to the garment. Another important consideration involves cost of the material. For example, a core of inexpensive material may be combined with a sheath of more expensive material. For example, the core may be formed from polypropylene or nylon and the sheath may be formed from a polyester or co-polyester. Many other multi-component fiber configurations exist, including side-by-side, tipped, and microdenier configurations, each having its own special applications. Various material properties can be controlled using one or more of the component liquids. These include, as examples, thermal, chemical, electrical, optical, fragrance, and anti-microbial properties. Likewise, many types of die tips exist for combining the multiple liquid components just prior to discharge or extrusion to produce filaments of the desired cross-sectional configuration.

One problem associated with multi-component extrusion apparatus involves the cost and complexity of the manifolds used to transmit liquid(s) to the spinneret or extrusion die. Typical manifolds are typically machined with many different passages to ensure that the proper flow of each component liquid reaches the die under the proper pressure and

temperature conditions. These manifolds are therefore relatively complex and expensive components of the melt spinning apparatus.

For these reasons, it would be desirable to provide a meltblowing apparatus having a manifold system which may be easily manufactured while still achieving the goal of effectively transmitting the heated liquid or liquids to the die tip.

Summary of the Invention

The invention generally provides a lamellar meltblowing die apparatus for extruding a heated liquid into filaments and directing air at the filaments. The apparatus is constructed with a plurality of plates each having opposite side faces. At least two of the side faces confront each other and have a liquid passage positioned therebetween for transferring the heated liquid. At least two of the side faces confront each other and have an air passage positioned therebetween for transferring the air. At least two of the side faces confront each other and have a heating element passage therebetween. A heating element is positioned within the heating element passage for heating at least one of the liquid and the air. An extrusion die is coupled with the plurality of plates and communicates with the liquid passage and the air passage for discharging the heated liquid as multiple filaments and for discharging the air at the filaments. The air may, for example, be heated or unheated process air with or without quench air.

The liquid passage is preferably formed by respective first and second recesses on adjacent plates that abut one another. Likewise, the air passage is formed by respective third and fourth recesses on adjacent plates that abut one another, and the heating element passage is formed by respective fifth and sixth recesses on adjacent plates that abut one another. Recesses from different ones of these pairs of recesses may, for example, be located on opposite sides of the same plate. In the preferred embodiment, multiple heating element passages are positioned between two of the plates and multiple heating elements are respectively contained in the heating element passages. The heating element passage or passages are preferably located between the liquid passage and the air passage.

The liquid passage and the air passage each include an inlet portion and an outlet portion with the outlet portion being wider than the inlet portion. The outlet portion of the liquid passage forms an elongate liquid outlet slot. A plurality of distribution passages communicate with an elongate air outlet slot in one of the plates and the distribution passages further communicate with the air passage. The extrusion die includes an elongate liquid inlet slot and an elongate air inlet slot respectively aligned in communication with the elongate liquid outlet slot and the elongate air outlet slot.

The invention further contemplates methods of meltblowing liquid filaments, such as single or multiple component thermoplastic polymeric filaments, in general accordance with the use of the apparatus described above.

Various advantages, objectives, and features of the invention will become more readily apparent to those of ordinary skill in the art upon review of the following detailed description of the preferred embodiments, taken in conjunction with the accompanying drawings.

Brief Description of the Drawings

Fig. 1 is a perspective view of a multi-component meltblowing apparatus constructed in accordance with a preferred embodiment of the invention.

Fig. 1A is an exploded perspective view of the apparatus shown in Fig. 1.

Fig. 2 is a cross sectional view taken along line 2-2 of Fig. 1.

Fig. 3 is a fragmented view of the assembled apparatus taken generally along line 3-3 of Fig. 2.

Fig. 4 is a cross sectional view similar to Fig. 2, but illustrating an alternative embodiment of the apparatus.

Fig. 5 is a cross sectional view taken along line 5-5 of Fig. 4.

Fig. 6 is a cross sectional view similar to Fig. 2, but illustrating another alternative embodiment of the apparatus.

Fig. 7 is a cross sectional view similar to Fig. 4, but illustrating another alternative embodiment of the apparatus.

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Figs. 1, 1A, 2 and 3 illustrate a die apparatus 10 constructed in accordance with a first embodiment. Apparatus 10 is comprised of a manifold structure 12 coupled for fluid communication with an extrusion die 14. Manifold structure 12 is a lamellar construction or plate assembly comprised of multiple plates 16a-c, 18a-c and 20. These plates are securely fastened together in side-by-side relation using appropriate fasteners 22 (only one shown in Fig. 1) extending through holes 24 in each of the plates. As best shown in Fig. 2, respective outside pairs of plates 16a, 16b and 18a, 18b form process air manifold sections and include respective air input ports 26, 28. Plates 16a, 16b and 18a, 18b respectively abut each other and contain air passages 27, 29 therebetween. Air passages 27, 29 are respectively formed by pairs of recesses 30, 32 and 34, 36 that align with each other in abutting faces of the plates 16a, 16b and 18a, 18b.

As shown best in Fig. 1A, these recesses 30, 32 and 34, 36 take the form of so-called coat hangar recesses which become wider in dimension from the inlet portion 40 located proximate input ports 26, 28 to an outlet portion 42 located proximate respective distribution passages 44. Distribution passages 44 extend respectively through plates 16b and 18b and lead to similar distribution passages 46, 48 in plates 16c and 18c and, finally, into elongate air outlet slots 50, 52 which extend lengthwise along the undersides of plates 16c, 18c and communicate with coextensive

elongate inlet slots 53, 55 in the top of the extrusion die 14. Plates 16c and 18c respectively abut central plate 20.

Respective liquid passages 54, 56 are formed between plates 16c, 20 and 18c, 20 and, again, are formed by respective pairs of coat hangar recesses 58, 60 and 62, 64 that align with each other in abutting surfaces of these plates 16c, 20 and 18c, 20. As shown in Fig. 1A, these recesses 58, 60 and 62, 64 are also formed with a coat hangar configuration between inlet portions adjacent respective liquid input ports 66, 68 and outlet portions which form elongate liquid outlet slots 70, 72 for abutting the top surface of the extrusion die 14 and aligning with coextensive liquid inlet slots 73, 75. In this embodiment, the two liquid input ports 66, 68 and coat hangar passages 54, 56 are provided for producing bicomponent filaments from extrusion die 14. Extrusion die 14 may be any suitable extrusion die having, for example, a laminated plate construction with appropriate porting and passages to combine and extrude filaments from the outlet orifices extending along the underside of the extrusion die 14 and to attenuate or otherwise affect those filaments with process air. Representative dies are, for example, disclosed in U.S. Patent Nos. 5,562,930; 5,551,588; and 5,344,297, however, such dies would require modification with suitable passages (not shown) to transfer and discharge process air received from air outlet slots 50, 52.

Also in accordance with the invention, heating elements 74, 76 are respectively contained in passages 80, 82 between plates 16b, 16c and 18b, 18c. Each passage is again preferably formed by respective pairs of

aligned and abutting recesses 84, 86 and 88, 90 in plates 16b, 16c and 18b, 18c. These heating elements 74, 76, which are preferably electrically operated heating elements, may be advantageously situated between the respective air and liquid passages 27, 54 and 29, 56 so as to heat both the liquid and the air traveling to extrusion die 14. Sufficient heat may also be supplied to heat the extrusion die 14 itself to the appropriate operating temperature.

Figs. 4 and 5 illustrate another apparatus 100 constructed in accordance with the invention. In this embodiment, apparatus 100 again comprises a multiple plate assembly or manifold structure 102 coupled with an extrusion die 104. Manifold structure 102 is similar to that described with respect to the first embodiment in that a seven plate construction 106a-c, 108a-c, 110 is used for providing both process air and two component liquids, such as polymers, to the extrusion die 104. However, in this embodiment, two additional plates 112, 114 have been added to the outside of the manifold structure 102 to supply quenching air through respective input ports 116, 118 and air passages 120, 122 in the form of coat hangar passages as described above, and respective transfer passages 124, 126 and 128, 130 respectively extending through plates 106a, 106b and 108a, 108b and communicating with appropriate passages (not shown) in the extrusion die 104. This quenching air functions to cool the filaments after they have been discharged.

As further shown in Figs. 4 and 5, input ports 140, 142 are provided for introducing two different component liquids, such as two different types

of polymer materials, into apparatus 100. In addition, input ports 144, 146 are provided for process air. Liquid input ports 140, 142 communicate with respective pairs of abutting and aligned recesses 148, 150 and 152, 154 which form coat hangar passages and communicate directly with elongate slots (not shown) in the top of extrusion die 104. Input ports 144, 146 communicate with respective pairs of abutting recesses 156, 158 and 160, 162 in plates 106a, 106b and 108a, 108b. These recess 156, 158 and 160, 162 also form coat hanger air passages which communicate with respective elongate slots 164, 166 in plates 106c, 108c through respective transfer passages 168, 170 and 172, 174 in plates 106b, 106c and 108b, 108c to provide process or attenuating air to die 104. Passages 120, 122 are likewise formed as coat hangar passages formed by abutting recesses 176, 178 and 180, 182 having narrower portions adjacent input ports 116 and 118 and wider portions adjacent respective transfer passages 124 and 128. Electric heaters 184, 186 are provided as in the first embodiment.

Fig. 6 illustrates another alternative die apparatus 200 having a laminated plate construction. This apparatus 200 is similar to that described above with respect to the first embodiment (Figs. 1, 1A, 2, 3), but is configured to discharge single component filaments or monofilaments rather than a bicomponent filament. Thus, the central plate 20 used in the first embodiment has been eliminated thereby resulting in a six plate construction rather than a seven plate construction for manifold structure 202. As with the previous embodiments, an extrusion die 204 is coupled

to manifold structure 202 for discharging one or more filaments and, optionally, discharging air to facilitate a meltblowing operation. However, for spunbond apparatus, it will be appreciated that the process air passages and structure associated therewith may be eliminated. A single liquid input port 206 and coat hanger passage 208 receive the liquid, such as a thermoplastic polymer. Coat hanger passage 208 is formed by aligned recesses 210, 212 in abutting faces of plates 16c' and 18c'. Plates 16c' and 18c' are designated with prime marks (') to denote that they are slightly modified, as illustrated, from plates 16c, 18c. All other aspects of apparatus 200 are as described above with respect to the first embodiment and, therefore, identical reference numerals have been used and no further description is necessary.

Fig. 7 illustrates another alternative apparatus 220 similar to that described above with respect to Figs. 4 and 5 but, like the embodiment of Fig. 6, apparatus 220 is configured to discharge single component filaments or monofilaments rather than bicomponent filaments. Again, the central plate 110 of the embodiment illustrated in Figs. 4 and 5 has been eliminated and an eight plate manifold structure 222 results. Manifold structure 222 is configured to deliver liquid, process air and quench air to an extrusion die 224. A single liquid input port 206 and a coat hanger passage 208 is formed between abutting plates 106c', 108c' to communicate with an appropriate elongate inlet slot (not shown) in the top of the extrusion die 224. Plates 106c' and 108c' are designated with prime marks (') to denote that they are slightly modified, as illustrated, from

plates 106c, 108c. All other aspects of the embodiment shown in Fig. 7 are described with respect to the embodiment of Figs. 4 and 5 and, therefore, identical reference numerals have been used and no further description is necessary.

While the present invention has been illustrated by a description of various preferred embodiments and while these embodiments has been described in some detail, it is not the intention of the Applicant to restrict or in any way limit the scope of the appended claims to such detail. Additional advantages and modifications will readily appear to those skilled in the art. The various features of the invention may be used alone or in numerous combinations depending on the needs and preferences of the user. This has been a description of the present invention, along with the preferred methods of practicing the present invention as currently known. However, the invention itself should only be defined by the appended claims, wherein we claim: